



Energy Technologies Area

Lawrence Berkeley National Laboratory

The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009–2015

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Agenda

- Why the cost of saving electricity (CSE) matters
- LBNL cost of saving electricity project
 - Data and analytical approach and program typology
 - What's in the database – program spending and lifetime savings by market sector
 - Definitions
- Program administrator (PA) CSE results
 - National, regional and market sectors
 - Select residential and commercial & industrial (C&I) programs and trends
 - Electricity efficiency cost curve
- Total CSE results
 - National, regional and market sectors
 - Select residential and C&I programs and trends
- Discussion and future research directions
- Q&A

Webinar Housekeeping Items

- ◆ We're recording the webinar and will post it on our web site.
- ◆ Because of the large number of participants, everyone is in listen mode only.
- ◆ Please use the chat box to send us your questions and comments any time during the webinar.
- ◆ Moderated Q&A will follow our presentation. Report authors will respond to questions in the chat box.
- ◆ The report and webinar slides are posted at <https://emp.lbl.gov/projects/what-it-costs-save-energy>

Why the cost of saving electricity matters

- To help ensure electricity system reliability at the most affordable cost as part of resource adequacy planning and implementation activities
 - Increasing role of efficiency as an energy and capacity resource, driven in part by state policies
 - Spending on utility customer-funded programs grew ~20% from 2011-2016*
 - Declining costs for some supply-side resources sharpens discussion of type and market share of clean energy investments
- To project efficiency's impact on electricity load forecasts
- To benchmark program results with regional and national estimates
- For initial screening of electricity resource alternatives
- To evaluate how program costs are likely to change over time with funding levels and participation

*Consortium for Energy Efficiency (2018). [*2017 State of the Efficiency Program Industry: Budgets, Expenditures, and Impacts*](#)

LBNL Cost of Saving Electricity Project: Data and Analytical Approach

Approach

- Collect & analyze reported annual energy efficiency (EE) program data

LBNL DSM Program Database

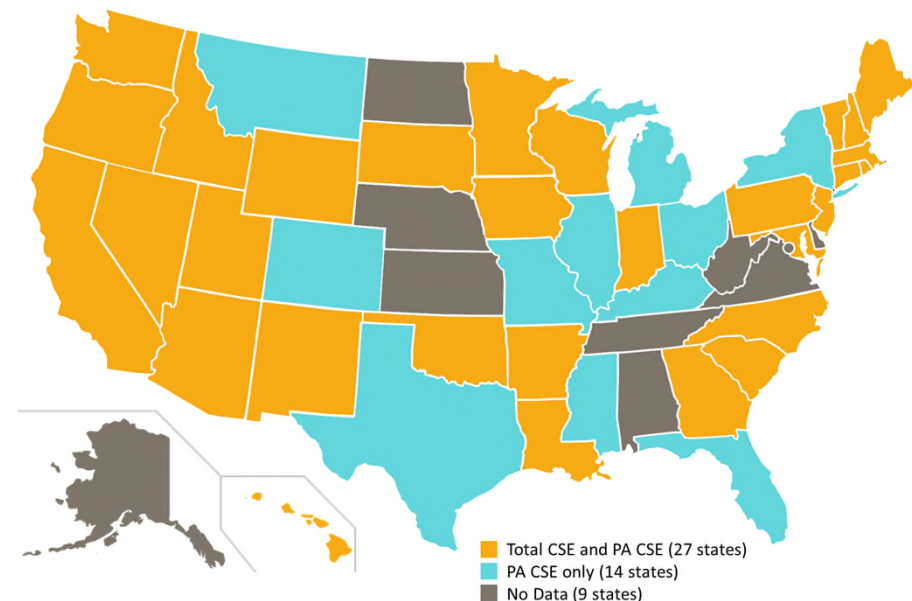
- Program Administrator CSE: 116 electricity EE administrators in 41 states
 - N = 8,790 program years (2009-2015)
- Total Cost of Saved Electricity: 67 administrators in 27 states
 - N = 4,590 program years

Data Collected

- Annual & lifetime savings
- Budgets & expenditure details
- Measure lifetimes for programs
- Participation

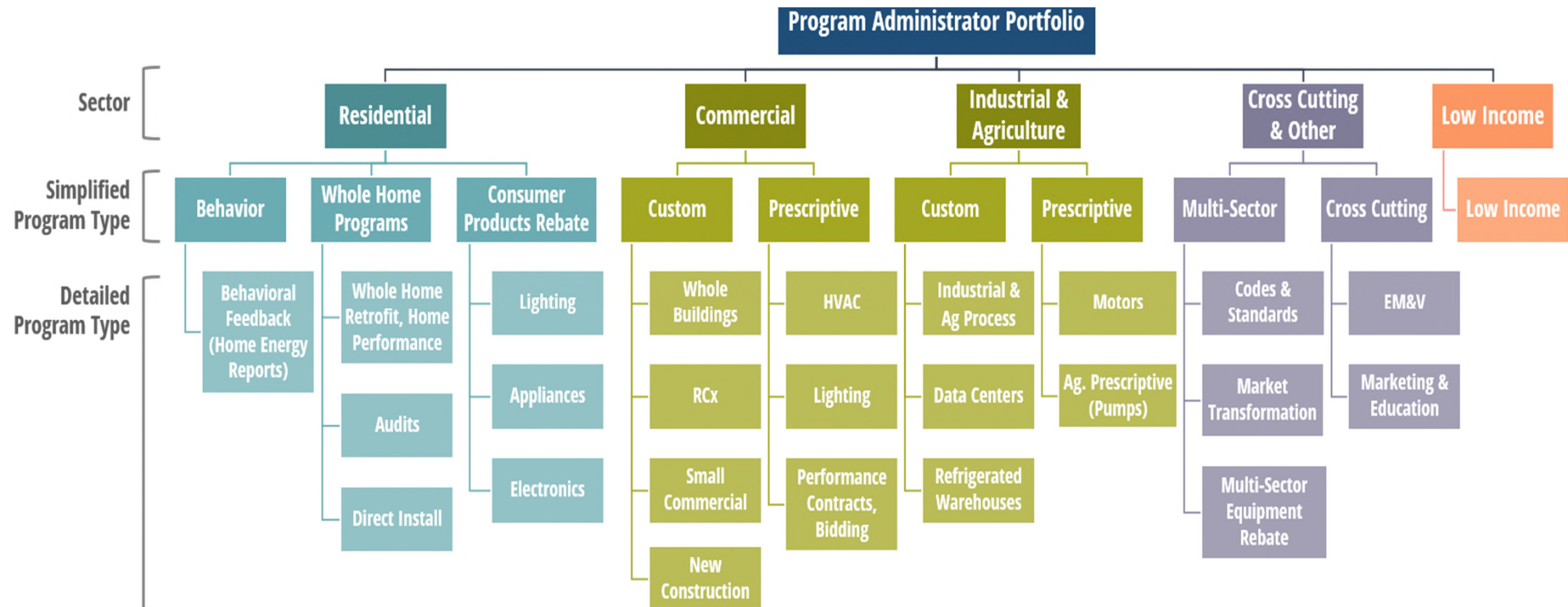
Standardization Is Critical

- A common DSM lexicon and program typology
- LBNL program reporting tools for:
 - Investor-owned utilities
 - Public power utilities



LBNL Efficiency Program Typology

- Characterizes programs by market sector, technologies and delivery approaches
 - Reflects range of reporting detail and enables multiple levels of analysis
- Six sectors, 27 simplified programs and >60 detailed program types

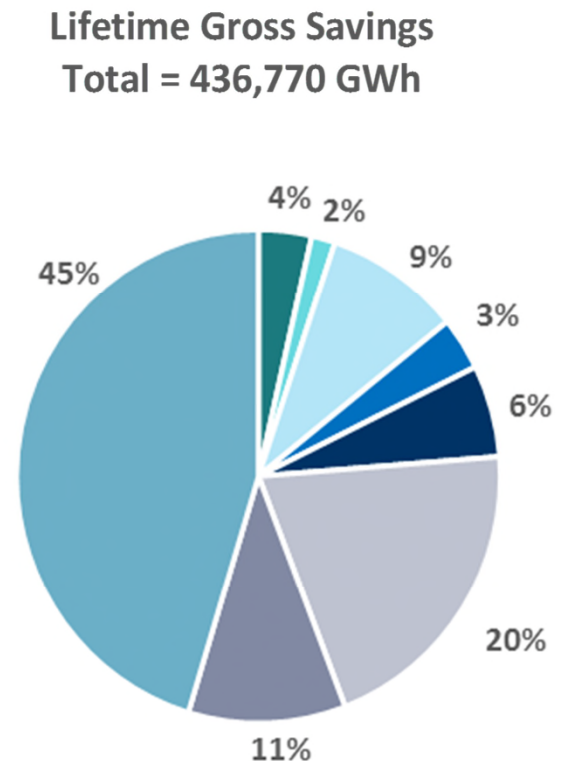
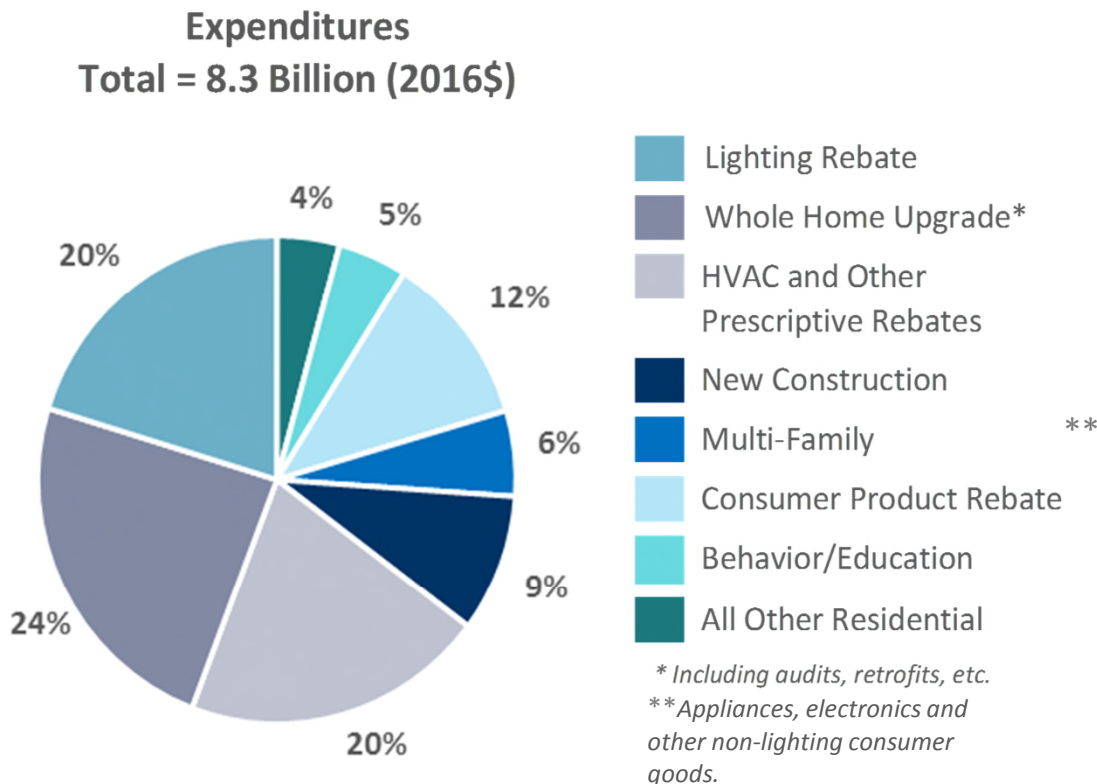


See LBNL brief, [Energy Efficiency Program Typology and Data Metrics: Enabling Multi-State Analyses Through the Use of Common Terminology](#)

**Figure is illustrative. Not all program types are depicted.*

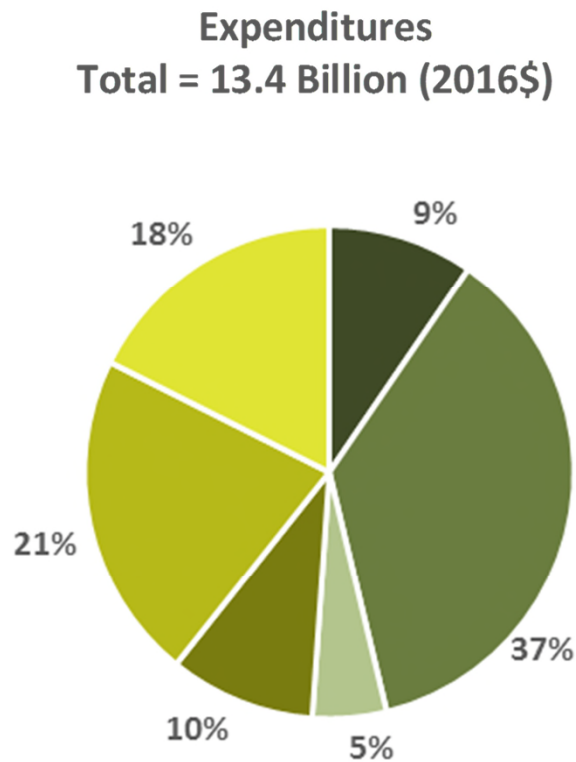
Residential Program Spending and Lifetime Savings

- \$8.3B in residential program spending from 2009 to 2015 in LBNL database
- Whole-home upgrades and prescriptive rebates together account for 44% of spending and 31% of lifetime savings
- Lighting rebate programs account for 20% of spending and 45% of lifetime savings



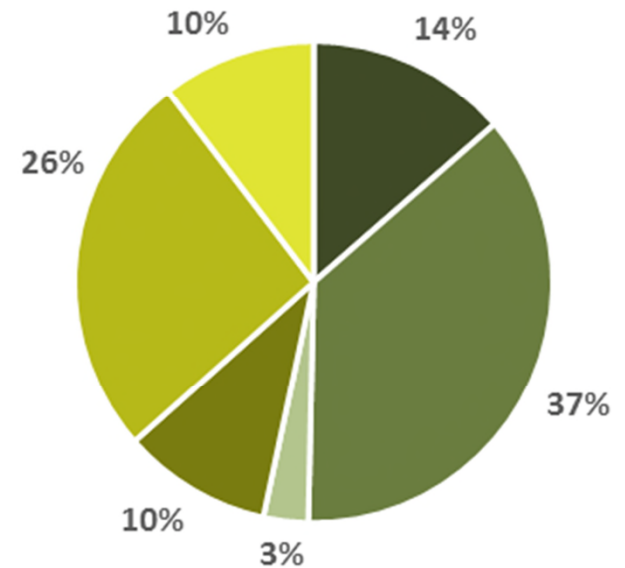
C&I Program Spending and Lifetime Savings

- \$13.4B in C&I program spending from 2009 to 2015 in LBNL database
- Custom rebate, prescriptive rebate, and small commercial programs account for about 3/4 of spending and lifetime savings



** Municipal/state governments, universities, K-12 schools and hospitals*

Lifetime Gross Savings
Total = 836,241 GWh



Definitions: PA and Total Cost of Saving Electricity

Levelized Program Administrator Cost of Saving Electricity (PA CSE)

The cost to the *program administrator* for achieving electricity savings over the economic lifetime of the actions taken, discounted back to when the costs were paid and the actions occurred

Levelized PA CSE for EE programs calculated using the following assumptions and inputs:

- 6% discount rate (real)
- Estimated program average measure lifetime
- Total program cost, including incentives (2016\$)
- Gross annual kWh saved

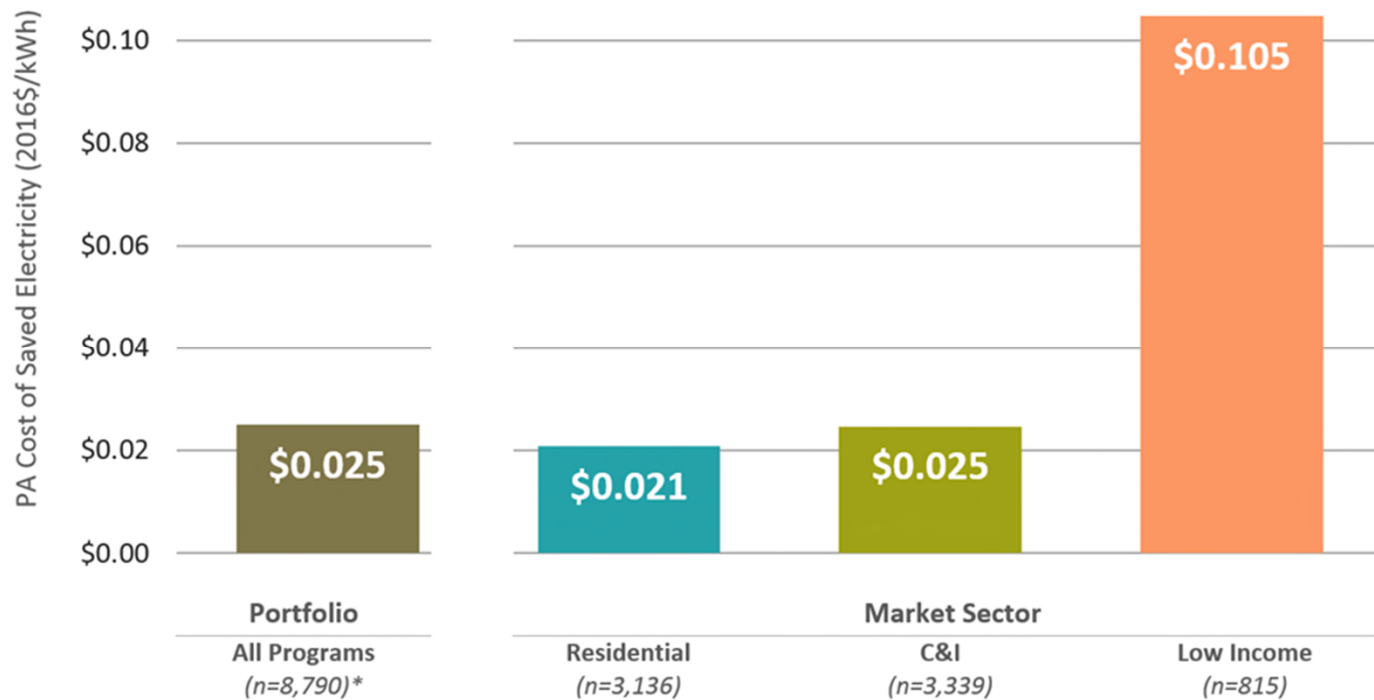
Levelized Total Cost of Saving Electricity (Total CSE)

The costs incurred by program administrators and participants for achieving electricity savings over the economic lifetime of the actions taken, discounted back to when the costs were paid. Participant costs are net of any incentives paid by the program.

Program Administrator Cost of Saving Electricity

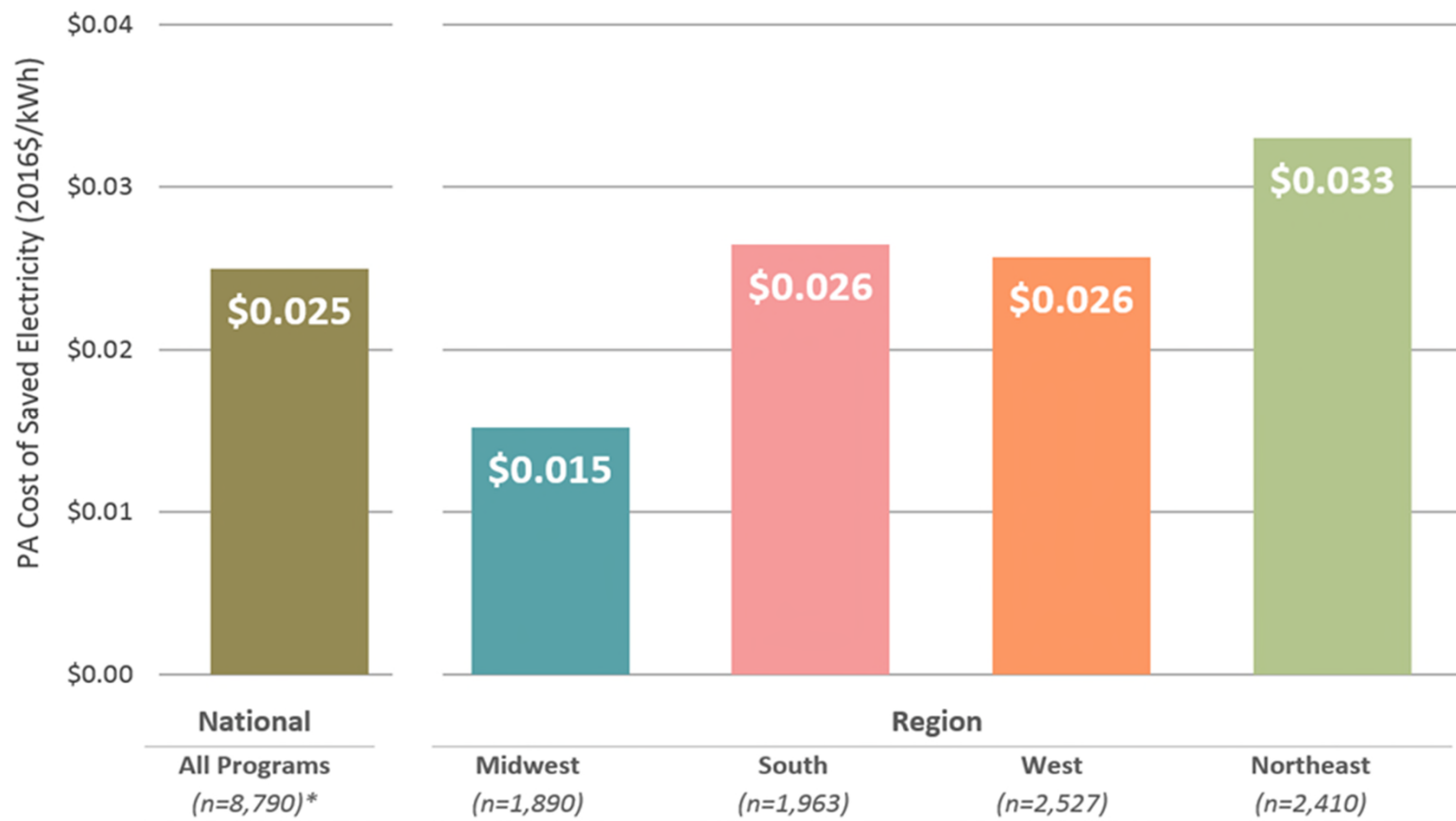
Program Administrator Cost of Saving Electricity: National Results (2009-2015)

- U.S. savings-weighted average PA CSE for all programs: \$0.025/kWh (2009-2015)
- PA CSE for residential programs: \$0.021/kWh, influenced strongly by lighting rebate programs
- PA CSE for C&I programs: \$0.025/kWh
- PA CSE for low-income programs: \$0.105/kWh (account for 2% of savings, 9% of spending)

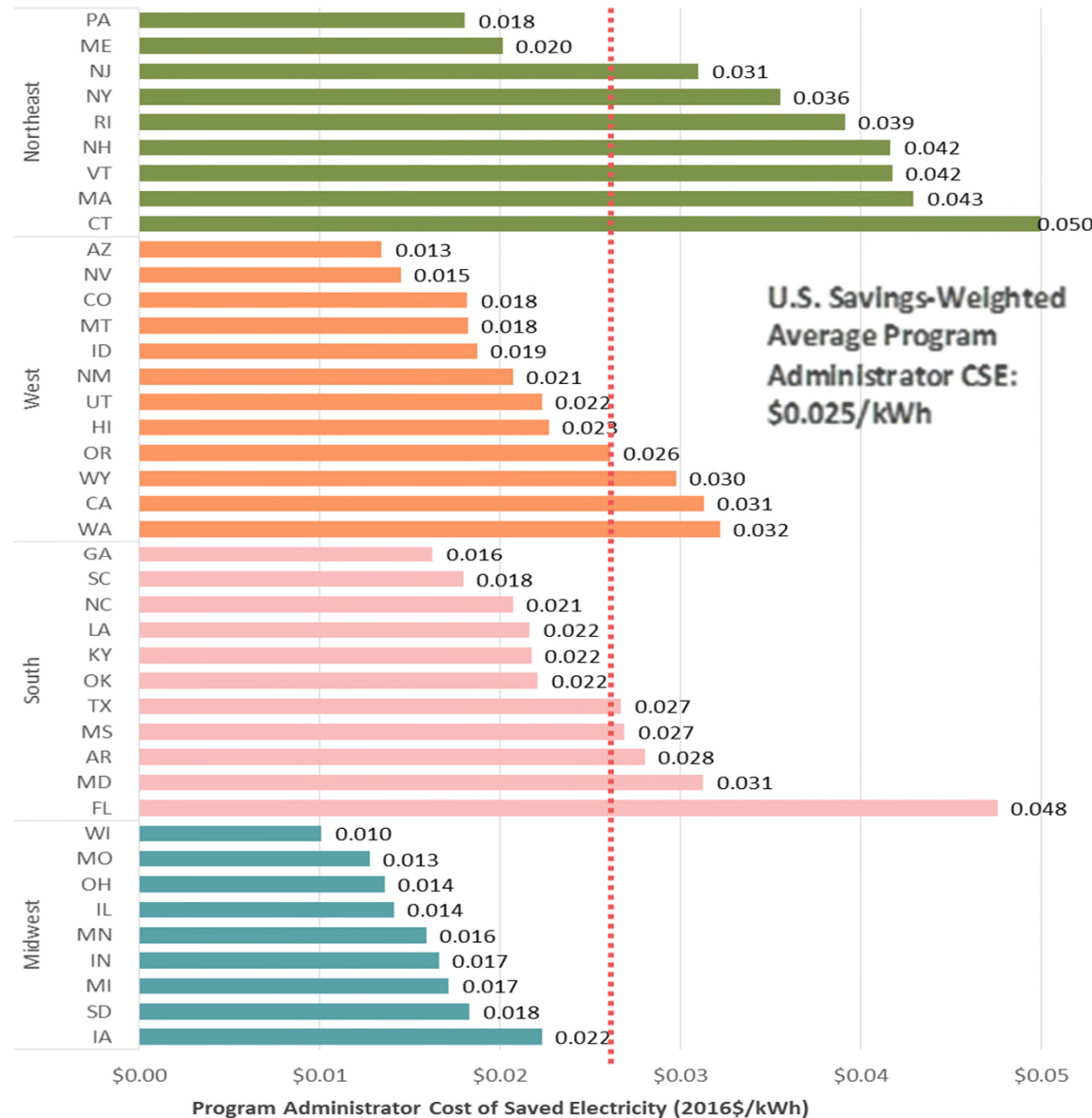


Program Administrator Cost of Saving Electricity: Regional Results (2009-2015)

- Savings-weighted PA CSE varied widely across regions: \$0.015 to \$0.033/kWh
- Comparable CSE values in South and West: \$0.026/kWh
- Midwest markedly lower: \$0.015/kWh. Many Midwest states ramped up programs between 2009 and 2015, with significant investment in low-cost programs.

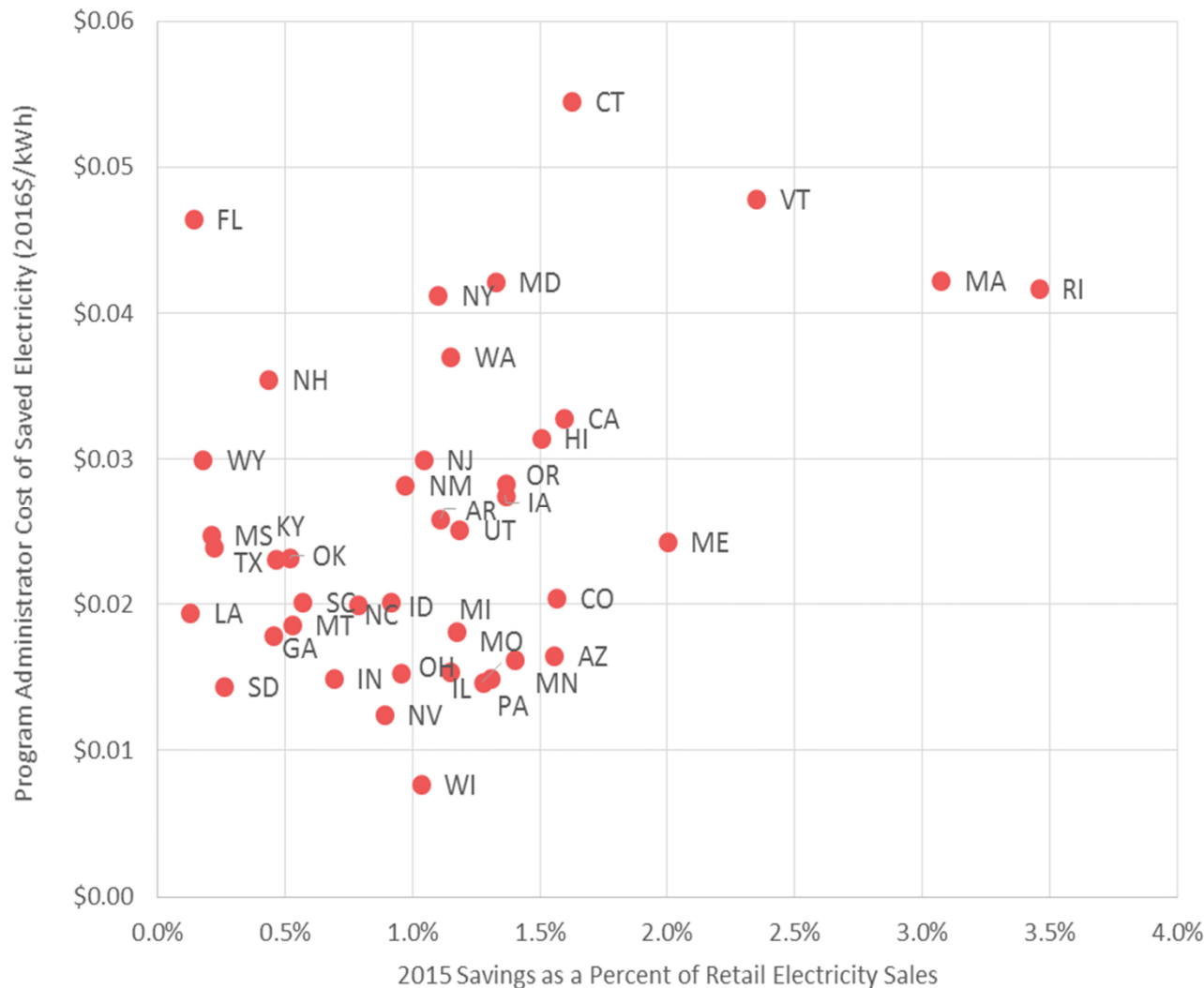


Program Administrator Cost of Saving Electricity: State-level Results (2009-2015)



- 17 states with a PA CSE of $\leq \$0.02/\text{kWh}$, concentrated in the Midwest, South and Intermountain West
- PA CSE greater than $\$0.04/\text{kWh}$ in five states. Four of these states (CT, VT, MA, and NH), in the Northeast, have relatively high electricity prices, extensive history with EE and strong policy commitments.

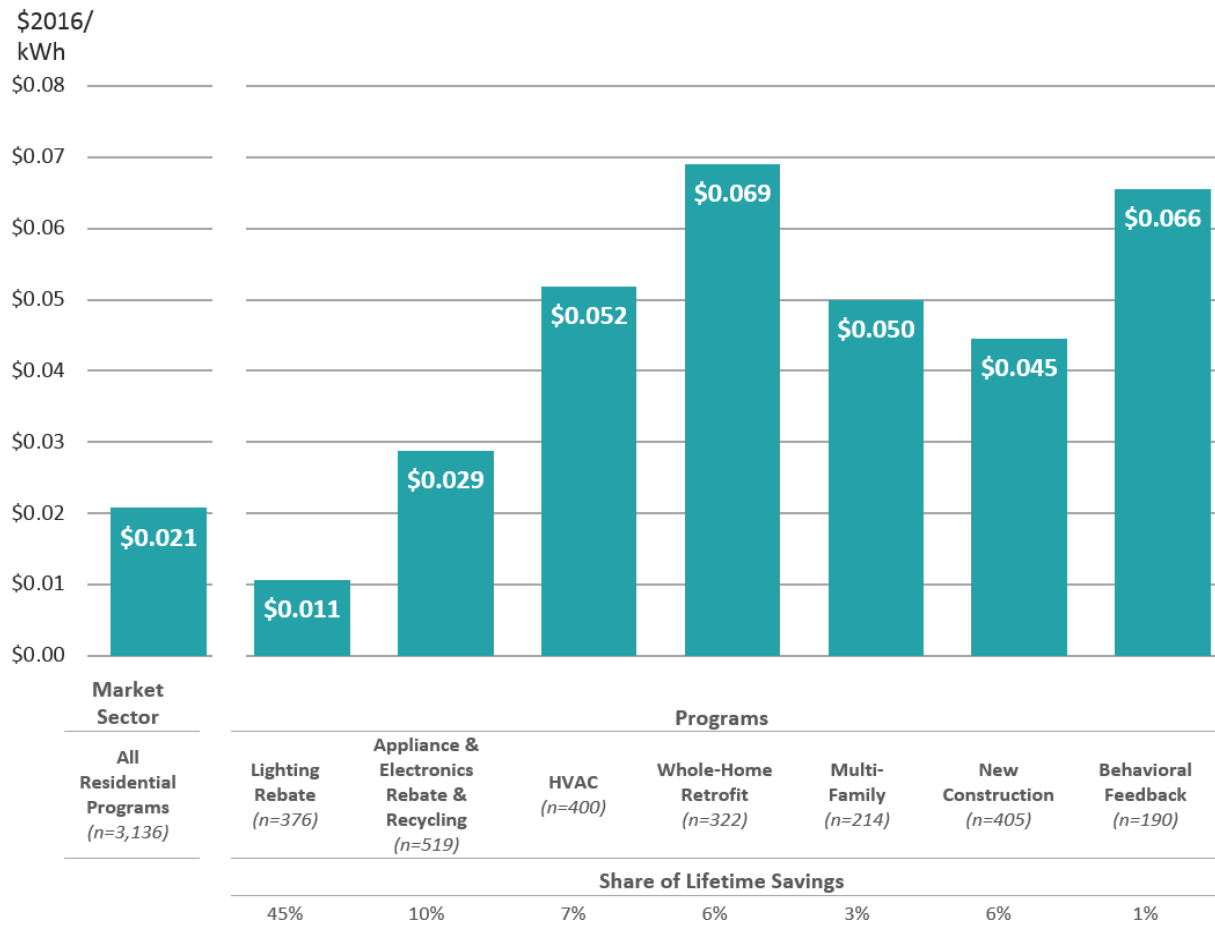
Program Administrator Cost of Saving Electricity: State-level Results (cont.)



- 2015 electricity savings expressed as % of 2015 retail sales
- PA CSE values tend to be higher in states that achieve more aggressive savings levels. 23 states reported annual electricity savings $\geq 1\%$ of retail sales
- Nine states in NE and West $>1.5\%$ savings
- Four states with $>2\%$ savings (ME, VT, RI, MA)

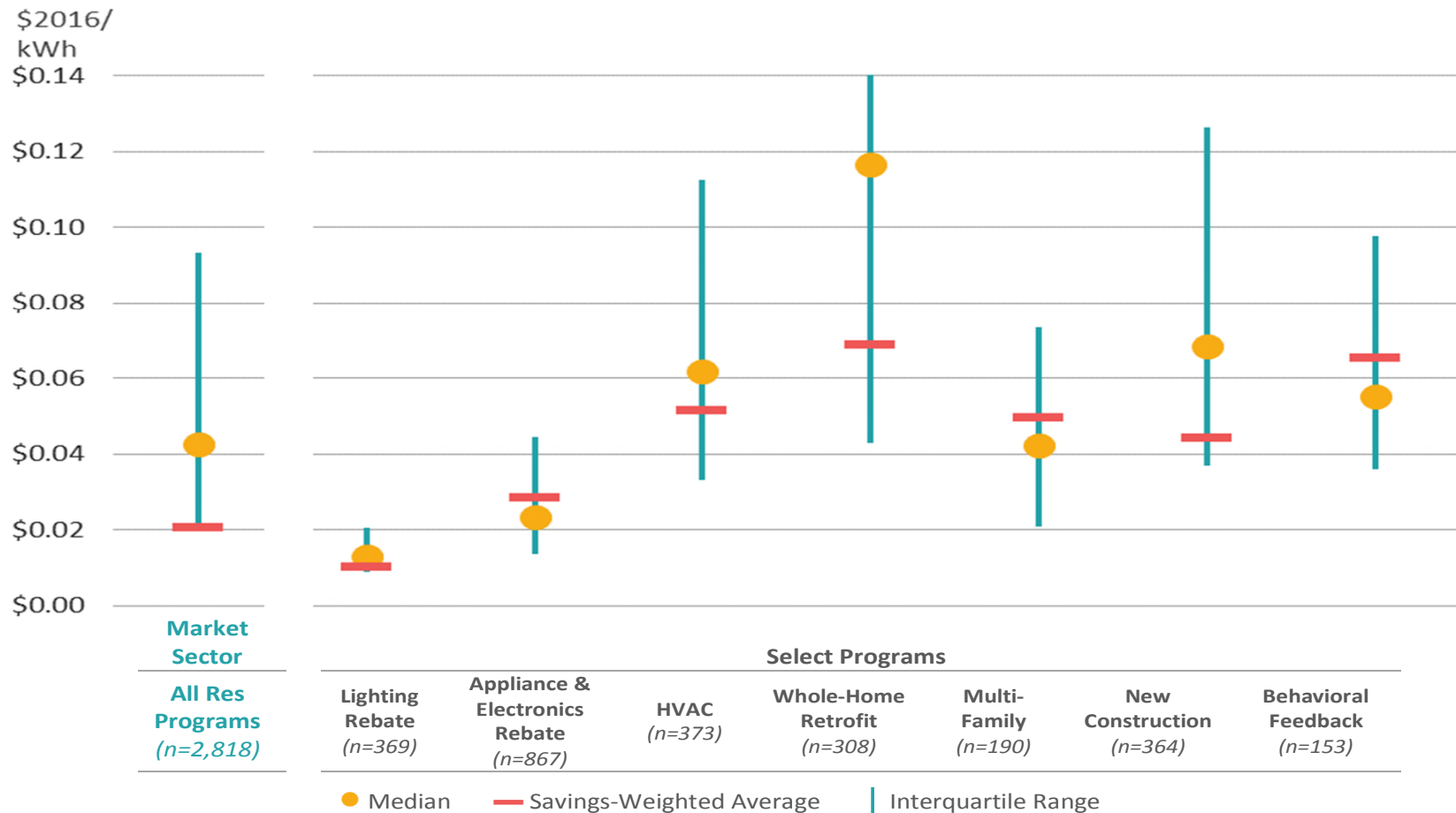
Program Administrator Cost of Saving Electricity: Select Residential Programs

- Wide range in residential PA CSE across programs: six-fold difference from lighting rebates (\$0.011/kWh) to whole-home retrofits (\$0.069/kWh)
- Lighting and consumer product rebates provide low-cost savings that allow PAs to offer other programs that are higher cost, but more comprehensive



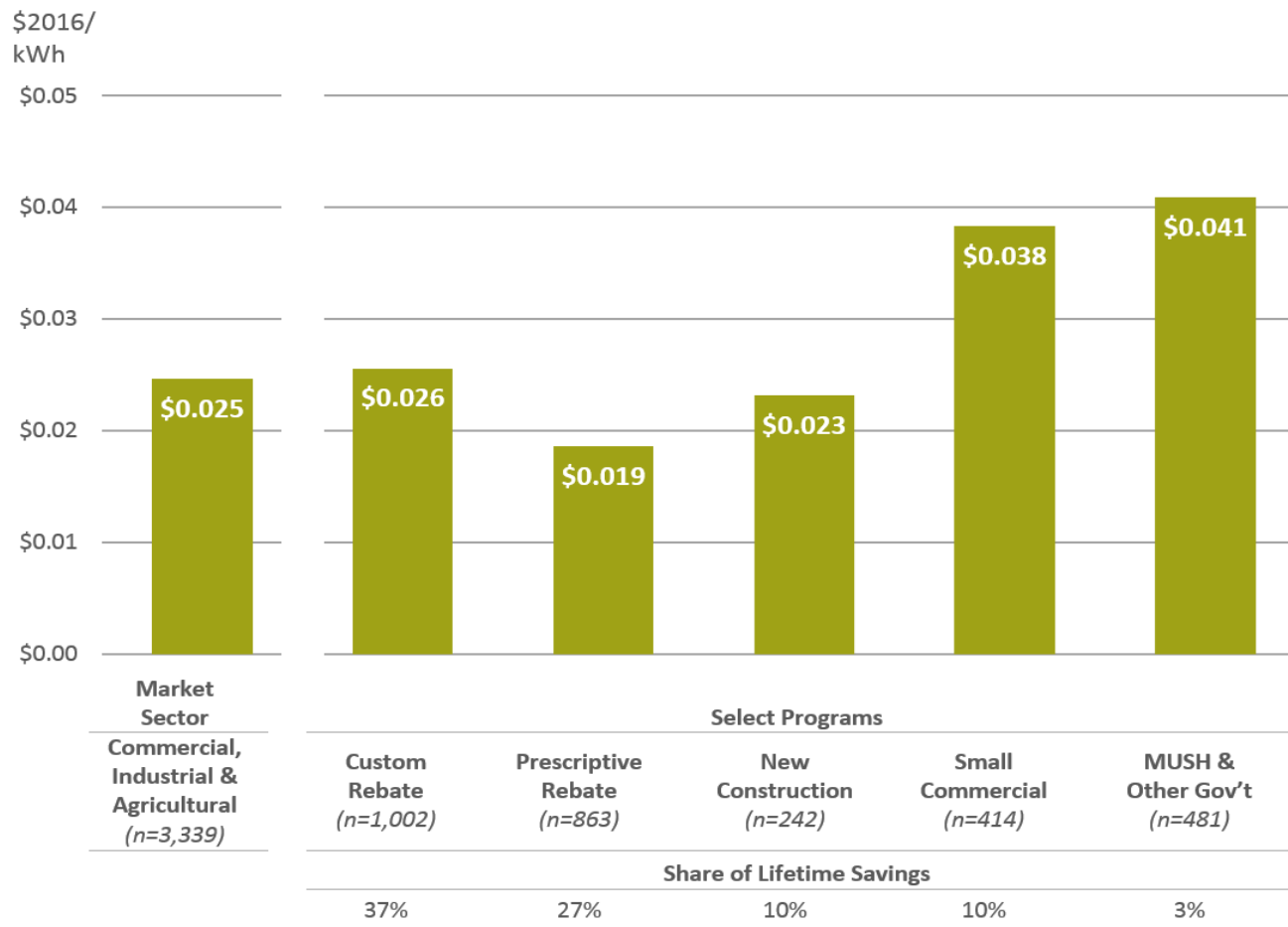
Program Administrator Cost of Saving Electricity: Median Values and Ranges for Residential Programs

- Median PA CSE for residential sector: \$0.042/kWh
- Low variability in PA CSE for lighting vs. other programs (HVAC, whole home retrofit, new construction) where variability in CSE values is greater — reflects diversity in program design and mix of measures



Program Administrator Cost of Saving Electricity: Select C&I Programs

- Savings-weighted PA CSE for C&I programs with largest savings — custom, prescriptive rebates, and new construction: \$0.019/kWh to \$0.026/kWh
- Savings are more evenly distributed across C&I program types, and average CSE varies only by a factor of two



Trends in the PA CSE: 2010-2015

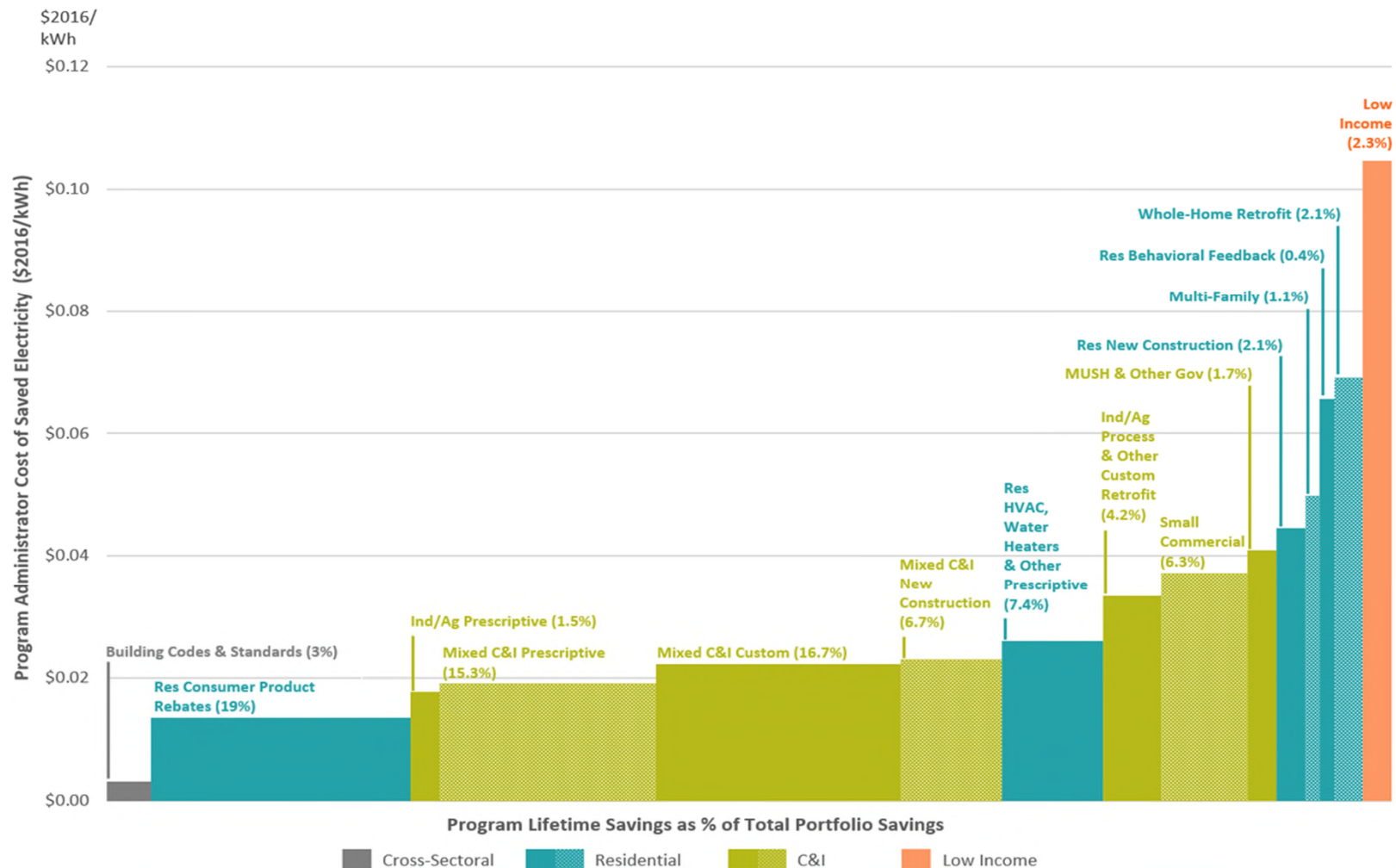
- 51 PAs with continuous data for 2010-2015
 - Average PA CSE increasing over time
- Divided into three groups based on annual savings
 - Average CSE increasing over time for highest and middle group of annual savers (larger PAs); decreasing over time for lowest savers (smaller PAs)
 - Average CSE for *individual* PAs is rising for higher savers, flat for middle savers, declining for lower savers

PA Group	2010	2011	2012	2013	2014	2015	CAGR: Savings-Weighted Average	CAGR: Mean Value
All 51 PAs	\$0.022	\$0.025	\$0.024	\$0.025	\$0.028	\$0.026	3.5%	0.2%
Highest Third	\$0.021	\$0.026	\$0.023	\$0.023	\$0.027	\$0.025	3.5%	3.8%
Middle Third	\$0.020	\$0.023	\$0.021	\$0.030	\$0.029	\$0.028	7.0%	0.2%
Lower Third	\$0.032	\$0.026	\$0.027	\$0.029	\$0.033	\$0.031	-0.6%	-2.8%

CAGR = compound annual growth rate

Program Administrator Cost of Saving Electricity: Program Savings Cost Curve

- Programs ordered by actual cost performance on x-axis; width scaled to represent lifetime savings
- Reinforces program analysis: Residential programs (blue) are least (and most) expensive; C&I programs (green) are steadier producers of savings



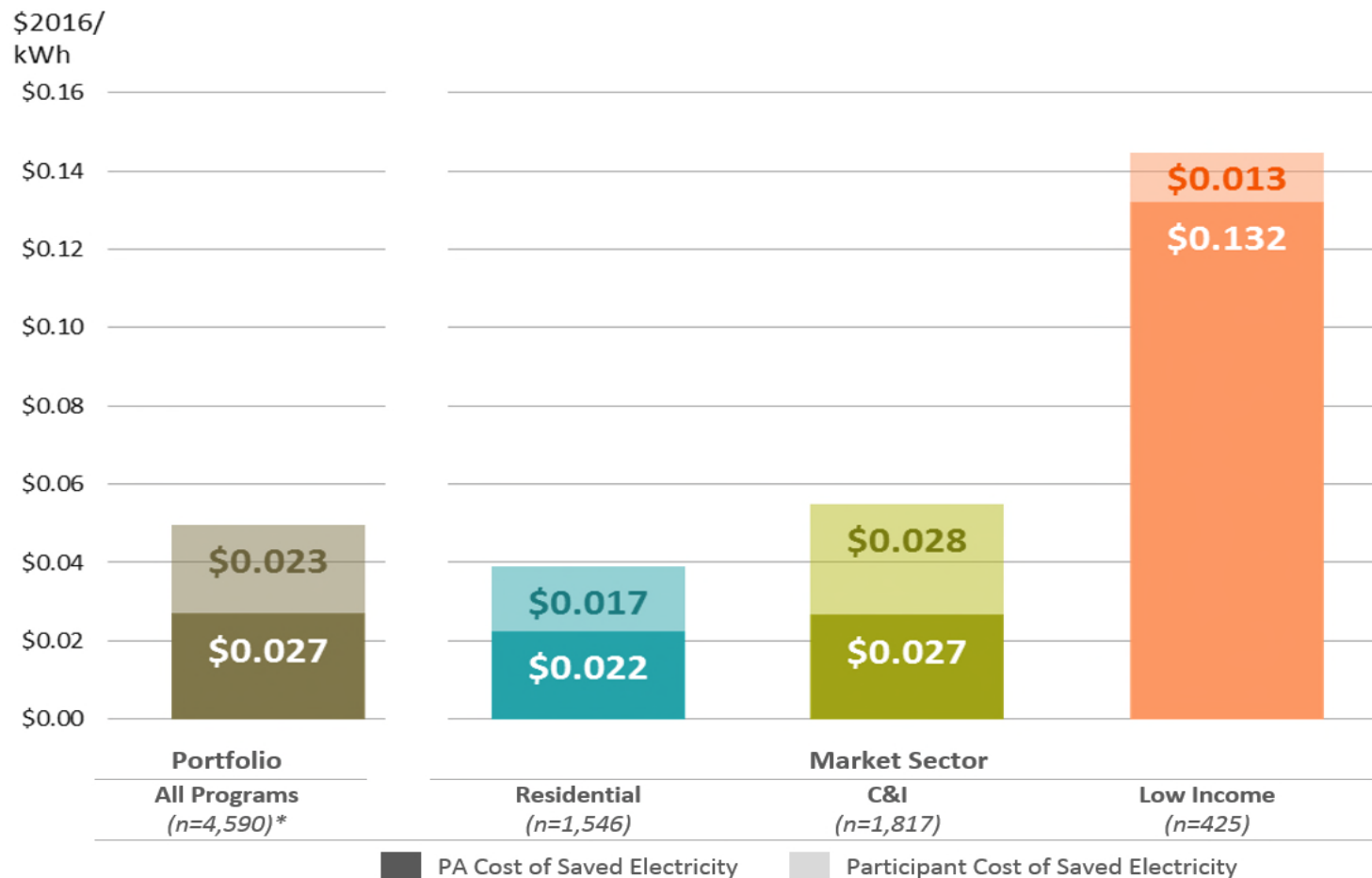
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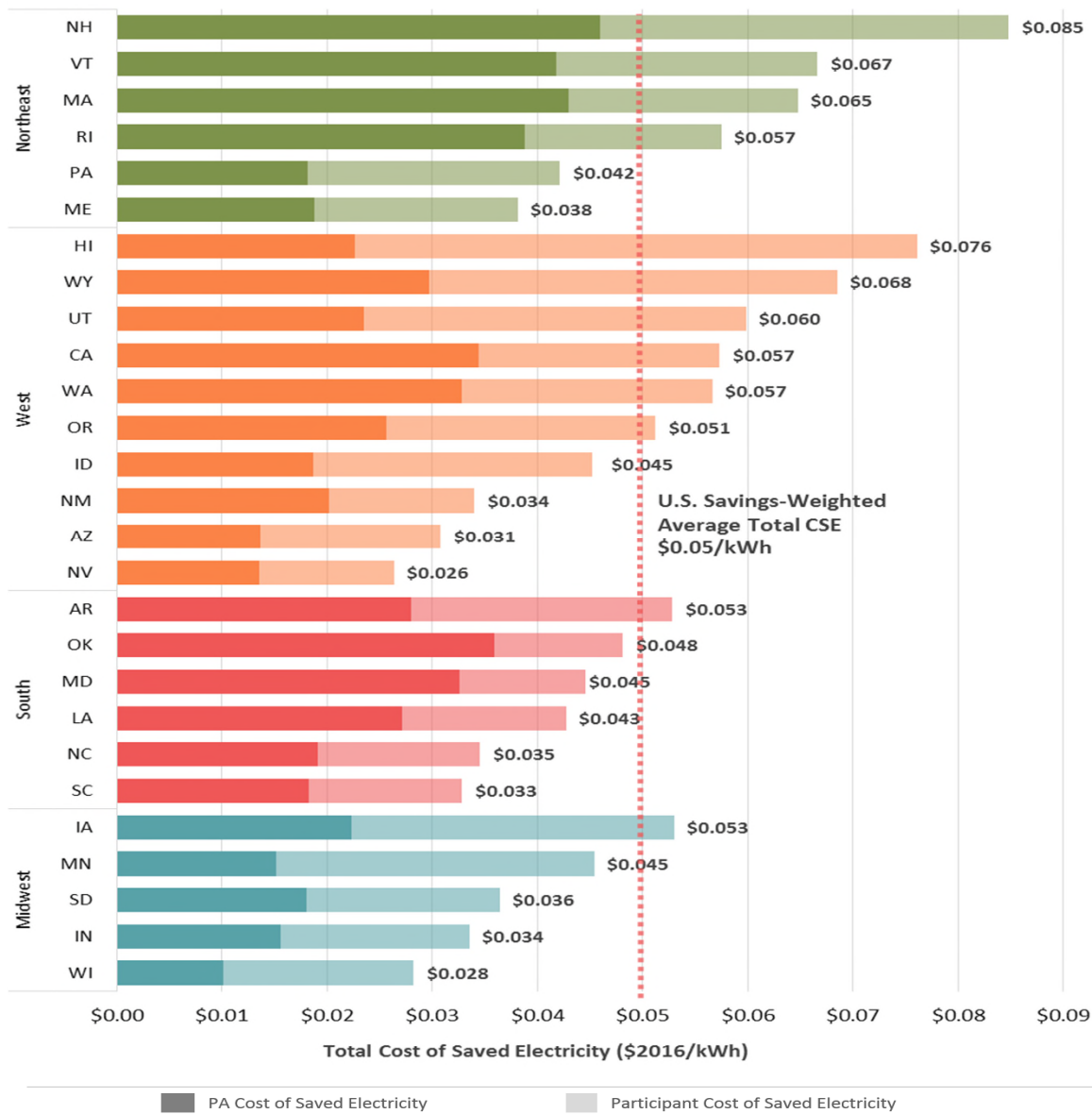
Total Cost of Saving Electricity

Total Cost of Saving Electricity: National Results (2009-2015)

- Savings-weighted average Total CSE: \$0.05/kWh for 67 program administrators in 27 states
- Residential programs: \$0.039/kWh (lowest-cost sector); low-income programs: \$0.145/kWh
- C&I programs: \$0.055/kWh



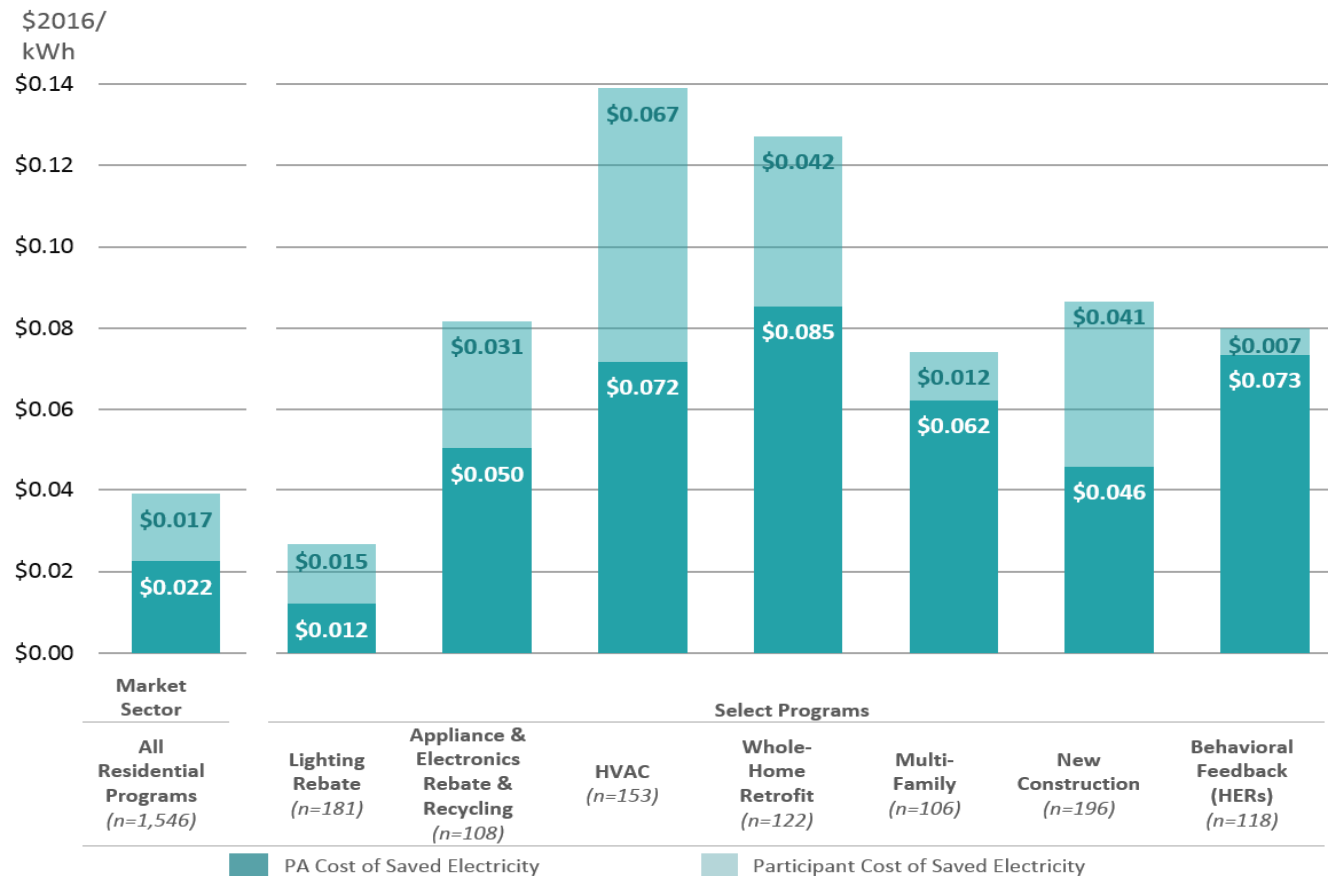
Total Cost of Saving Electricity: State-level Results



- Total CSE varied by more than a factor of three between the lowest and highest cost states (\$0.026/kWh vs. >\$0.08/kWh)
- Total CSE <0.04/kWh for one-third of states
- Relative share of Total CSE paid by PAs vs. participants varied significantly among states
- Midwest program participants tend to pay a greater share than PAs; opposite trend in South

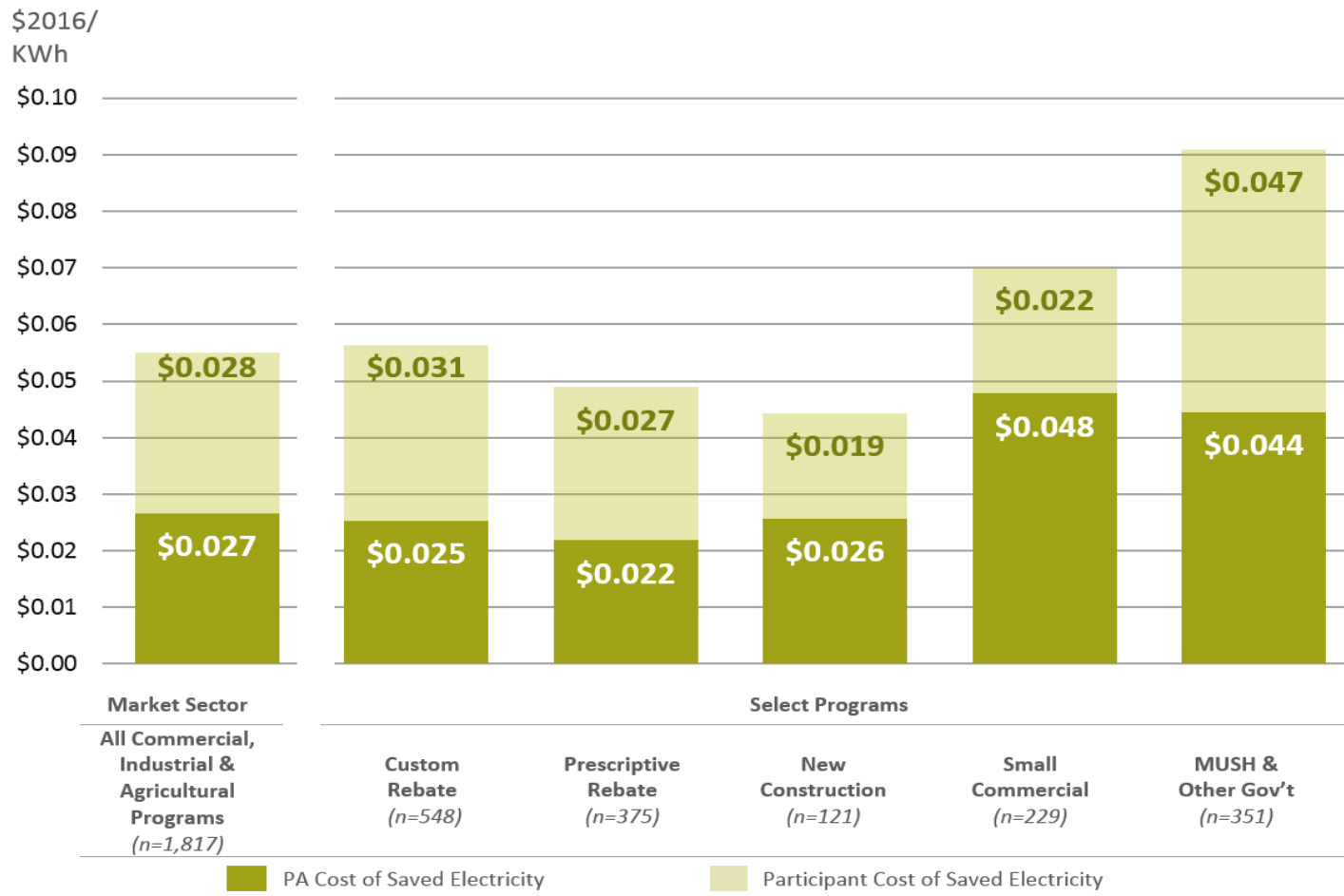
Total Cost of Saving Electricity: Results for Select Residential Programs

- Total CSE for residential sector: \$0.039/kWh
- Nearly half of savings from lighting rebate programs (\$0.027/kWh), with participants paying 55% of costs; drove sector results
- For other programs, ranged from \$0.074/kWh for multifamily to \$0.14/kWh for HVAC



Total Cost of Saving Electricity: Select C&I Programs

- Average Total CSE for C&I sector: \$0.055/kWh — ~40% higher than residential average
- Custom retrofits (\$0.056/kWh), prescriptive rebates (\$0.049/kWh) and new construction (\$0.045/kWh) account for 76% of C&I savings
- Participants in C&I custom programs invest moderately more than the PA — 55% vs. 45%



Discussion and Future Research Directions

Discussion: Key Findings and Potential Implications

- Cost of saving electricity remains low. Average cost to utilities is \$0.025/kWh.
- Significant variation in CSE by region, with lower CSE values in South and Midwest
- Average PA CSE values increased by 3.5% per year between 2010 and 2015 for 51 PAs with complete program data
- National “cost curve” for existing electricity efficiency programs reveals these insights:
 - Low-cost savings from residential lighting and consumer products reduce costs for the overall portfolio, accounting for 45% of lifetime savings in residential sector and 19% for national portfolio
 - Combined impact of increased market penetration of LEDs and federal lighting standards that will take effect in 2020 could reduce opportunities to acquire low-cost savings in residential lighting
 - C&I core programs — rebates for custom projects, prescriptive measures and new construction — deliver nearly half of lifetime savings. Bulk of savings come from larger C&I customers.
 - If more states allow large C&I customers to opt out of efficiency programs, PAs may rely more on savings from small and mid-size C&I customers. A shrinking C&I market may put upward pressure on CSE values in the C&I sector.
- Contraction in savings potential for lighting and core C&I savings can have large impacts on where savings come from and program cost-effectiveness, and therefore how much efficiency can be acquired.
- Behavioral feedback programs have proliferated and help achieve annual savings targets. However, their role as a significant electricity system resource is less apparent under current EM&V practices.

Program Data Reporting: Progress and Challenges

- Progress

- Program-level reporting of electricity efficiency costs and impacts is increasing
- Granularity and quality of reporting are improving
- More PAs are reporting participant costs (54% in our database)
- More detail on program costs by cost category

- Challenges

- Consistency, completeness and transparency of program data - Still significant room for improvement
- Program average measure lifetimes - Only 27% of PAs in our database report measure lifetimes or lifetime savings, with significant variability in lifetimes for similar programs.
- Participant costs - Challenging area, more transparency needed regarding PA practices
- Net savings definitions and values
- A few utilities and states continue to withhold or redact program data.

- Full, detailed reporting is important for grid operators, utilities, and public utility commissions to increase confidence in energy efficiency as an electricity system resource and to make better informed decisions.

Future Research Directions

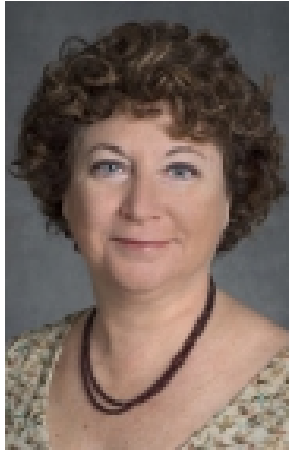
- Broaden scope to include public power utilities
- Develop metrics to report on peak demand impacts
- Update the cost of saving natural gas
- Estimate CSE values based on net savings
- Improve understanding of CSE by cost category
- Compare cost performance trends of efficiency and supply-side resources

Q&A

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Cost of Saving Electricity Team

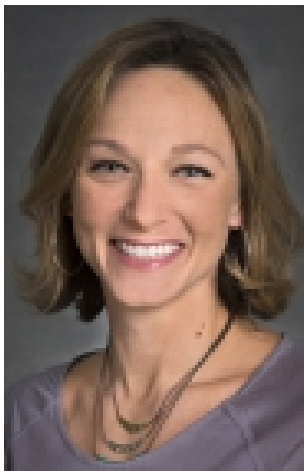
Principal Investigators



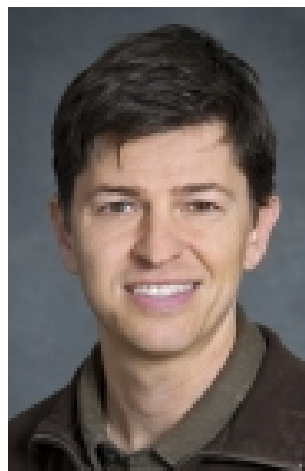
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